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A SCHEDULED AT-SEA SIMULATION OF ADAPTIVE BEAMFORMING.

by

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ABSTRACT

The Least Mean Square algorithm is a method of extracting a target signal in the presence of interfering noise sources. The method and the computer tests for simulated conditions utilizing random numbers, are reviewed. These tests indicate that the method is feasible for laboratory conditions. The purpose of a sea test is to evaluate the method for actual ocean conditions. The proposed experiment is part of project PARKA and will use elements of the Sea Spider array, the USNS SANDS (AGOR-6), and the Univac 1230 computer system. The data will be processed in real time. The experiment and computer program are described.

INTRODUCTION

In this memorandum, the proposed experiment of adaptive beamforming is reviewed. The review includes a brief description of adaptive beamforming, the sea spider array, the proposed experiment and the computer program.

ADAPTIVE BEAMFORMING

We will follow the theory developed by Widrow[1] and Griffiths[2] on the subject of adaptive beamforming. A tapped delay line is attached to each element of a K element array. There are L weights in each tapped delay line. (See Figure 1). The purpose of the algorithm is to adjust the weights such that there is a least mean square (LMS) difference between the output y and the expected signal. The problem was first solved by Wiener and the final answer was in terms of an inverse matrix.

254 200

Widrow and Griffiths obtained an approximate iterative solution. The main attractive features of the solution is that the noise field need not be known before hand and that it is not necessary to invert a matrix. In our simulation, the power spectrum of the signal is assumed to be known. In obtaining the LMS difference, the noise tends to be minimized and the pattern of the array tends to have notches where the noise interferences are strongest.

The adaptive beamforming test has been successfully simulated by the use of random number data by students at Stanford University. The purpose of this test is to examine adaptive beamformer performance under actual ocean conditions.

SEA SPIDER ARRAY

The Sea Spider array is approximately 350 miles north of Hawaii. It is a 3 legged array, each leg being 45° from the vertical. The array is buoyed up by an ellipsoidal subsurface float. In addition, over 3000 hollow glass spheres are mounted on the three legs, making the legs neutrally buoyant. The tension in the 3 cables and the neutrally buoyant elements attached to them combine to render a stable and rigid support for the array. The total number of hydrophones is 30 and there are 10 elements per leg. The depth of the water at the array site is about 19,000 ft.

PROPOSED EXPERIMENT

A linear 5 element array will be used in the experiment. The four distances between nearest neighboring elements are 21 ft, 52 ft, 100 ft and 171 ft.

A 400 cps projector will be suspended from the USNS SANDS (See Figure 2). The depth of the projector will be at 1000 ft. The 5 element array is at a depth of 2500 ft. The ship will be 12,000 ft from the array so that the projector is in the Fraunhoffer region of the array. The surface reflected, direct and bottom reflected rays will arrive at 28.7°, 37.9° and 115.8° respectively from the broadside direction of the array.

The Honeywell projector is driven by a pseudo-random noise (PRN) signal centered at 500 Hz in a 200 Hz band. The projector transmitting response curve is shown in Figure 3. The HX-90 has a maximum source level of 100.6db (re 1μbar at 1 yd). Driving the projector with a PRN signal reduces the source level to 91.1 db and at a range of 12,000 ft the expected acoustic level at the receiving hydrophones is +19.1db.

A block diagram of the transmitting system is shown in Figure 4. A PRN signal that can either be continuous or gated is filtered through a Butterworth filter that has a 200 Hz bandwidth centered at 500 Hz. The signal is then amplified and transmitted. The CML amplifier has a maximum output power of 5 KW and with a 40% projector efficiency, the electrical power is more than adequate to drive the projector at full power if required.

A block diagram of the receiving equipment is shown in Figure 5. The signal received at the hydrophone is amplified and the information is telemetered back to the ship where it is filtered through identical Butterworth filters and recorded on magnetic tape in analog form. The analog signals also go to a 12 bit A/D converter and these are processed on the 1230 Univac computer. The digitized signals are also recorded on Univac 1540 magnetic tape. Each execution of the LMS Pattern Program results in three records and an end of file being written on the Univac 1540 magnetic tape units. All records are recorded at 800 BPI, Odd Parity, Modulus 6, and in Bioctal Format. The order of the three records are shown in Figure 6. The details of the format for each of these records is shown in Figure 7 and 8.

COMPUTER PROGRAM

The updating of the weights is obtained from equation (1).

$$\underset{\sim}{w}(i) = \underset{\sim}{w}(i) + \nu\left[\underset{\sim}{ps}(i) - y\,\underset{\sim}{x}(i)\right]$$

$$y = \sum_{i=1}^{KL} w(i)\,x(i) \qquad (1)$$

where
x(i) are the KL inputs
y is the output
ps(i) is the signal correlation
ν is an arbitrary constant
w(i) are the KL weights

The inputs x(i) are hard clipped. The CS-1 program in fixed point arithmetic for equation (1) is given in appendix A.

The beam pattern P(Θ) for a given set of weights is given by equation (2). See reference 3 for a full explanation of this equation.

$$P(\theta) = \sum_{p=0}^{9} \epsilon_p R(p\Delta) \sum_{m=0}^{4} C(m,m,p)$$
$$+ 2 \sum_{n=0}^{3} \sum_{m=n+1}^{4} R\left[\frac{(d_m - d_n)}{c} \cos\theta\right] C(m,n,0)$$
$$+ 2 \sum_{p=1}^{9} \sum_{\substack{m=0 \\ m \neq n}}^{4} \sum_{n=0}^{4} R\left[p\Delta + \left(\frac{d_m - d_n}{c}\right)\cos\theta\right] C(m,n,p)$$

$$\epsilon_p = 1,\ p = 0 \qquad (2)$$
$$= 2,\ p \neq 0$$

$$R(\tau) = \frac{\sin \pi W \tau}{\pi W \tau} \cos(2\pi f_0 \tau)$$

$$C(m,n,p) = \sum_{i=0}^{9-p} W(m, p+i)\, W(n,i)$$

The subroutine for equation 2 is given in Appendix B.

COMPUTER RESULTS

Random Gaussian numbers were used to simulate a plane wave striking the array at an angle of 22° from broadside. The power spectrum corresponding to the time waveforms was flat with a center frequency of 250 cps and a bandwidth of 300 cps. The conventional pattern of the equally weighted 5 element array is shown in Figure 9. Using the LMS algorithm and a ν =.01, the weights of the tapped delay line were updated and after 2000 iterations, the pattern corresponding to these weights was computed. The result is shown in Figure 10. After 4000 iterations, the pattern shown in Figure 11, was obtained. The maximum sensitivity is 0 db in the look direction, i.e. the broadside direction in this case. A null of greater than -20db is

obtained in the interference direction.

CONCLUSIONS

A computer program using CS-1 language and fixed point arithmetic has been written and is operating successfully on simulated data. This program will be used at sea to test the applicability of adaptive beamforming under actual ocean conditions.

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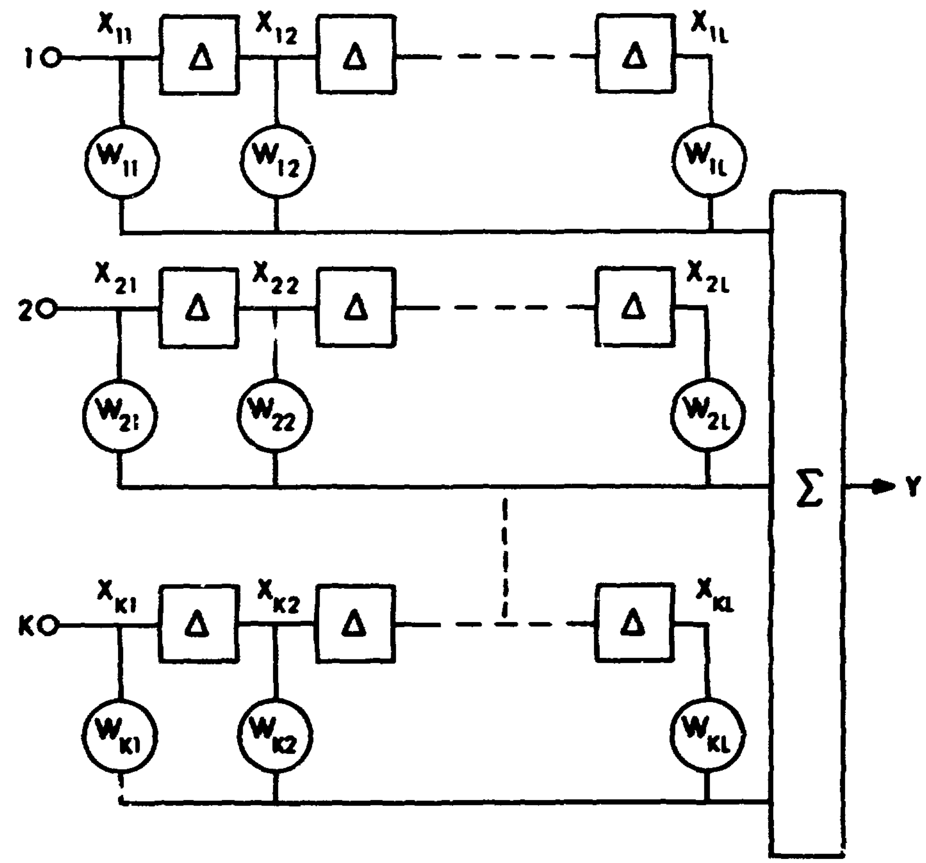
REFERENCES

(1) B. Widrow, P. Mantey, L. Griffiths, and B. Goode, "Adaptive Antenna Systems," Proc. IEEE, 55, 12, Dec 1967.

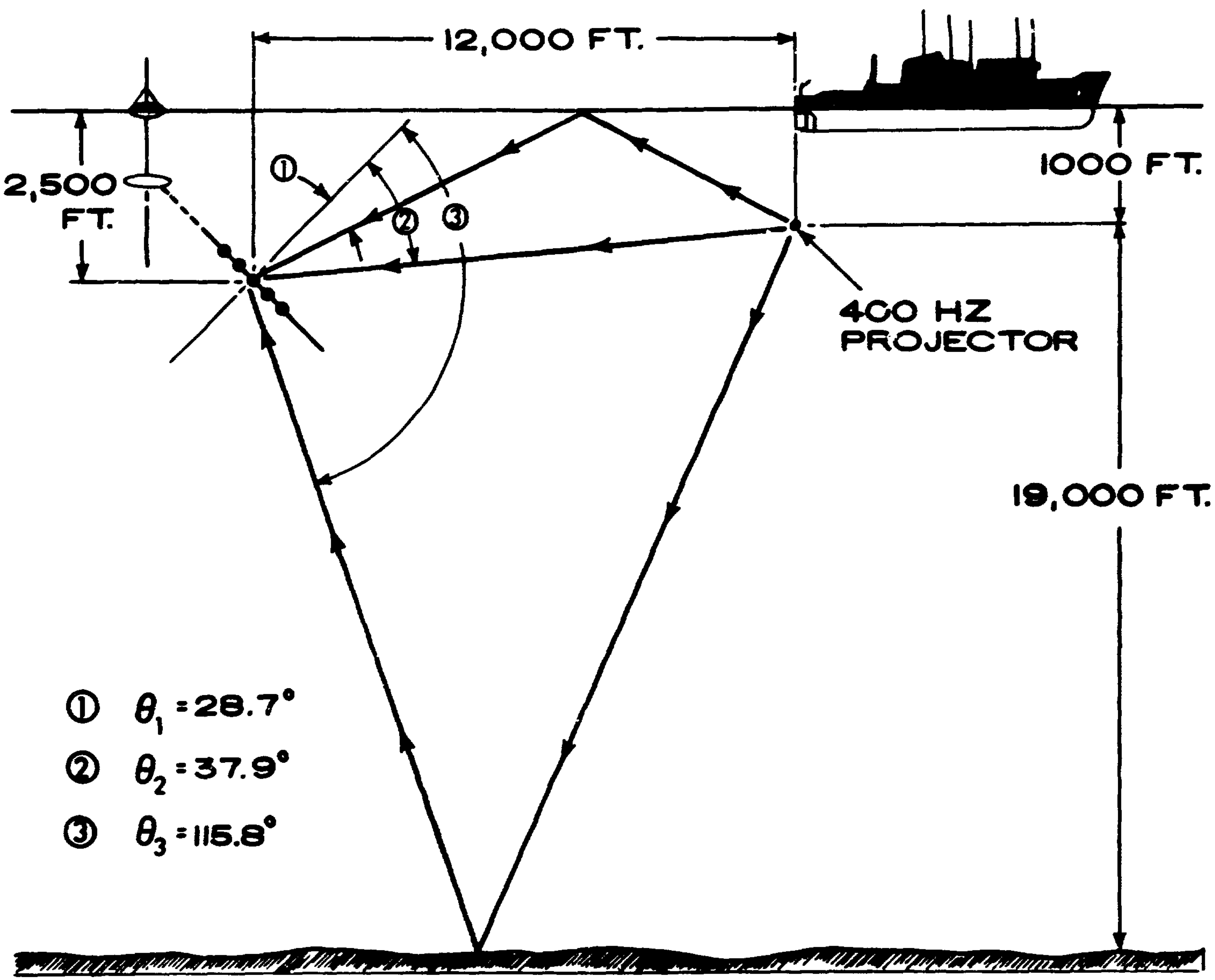
(2) L. Griffiths, "Signal Extraction Using Real-Time Adaptation of a Linear Multichannel Filter," Technical Report #6788-1, Stanford University, Feb 1968

(3) A. Nuttall, D. Hyde, B. Cron, "Efficient Computation of Beam Patterns for Arrays with Tapped Delay-Line Combiners," USL Tech Memo 2020-88-69, May 1969.



ADAPTIVE BEAMFORMER

Figure 1



U. S. Navy Underwater Sound Laboratory **Official Photograph**
NP24 - 36088 - 6 - 69

Figure 2

NUSL Tech Memo
No. 2211-162-69

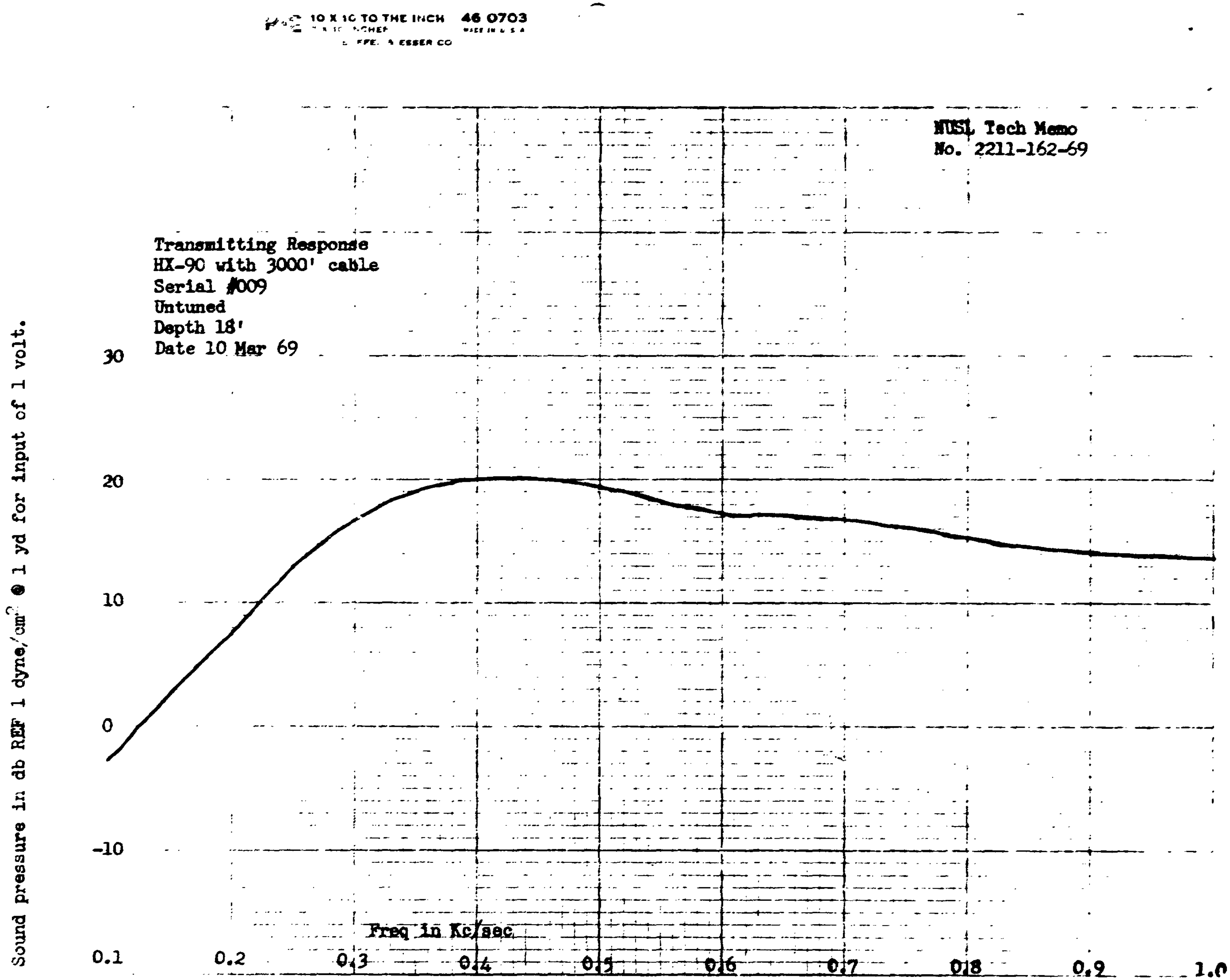


Figure 3

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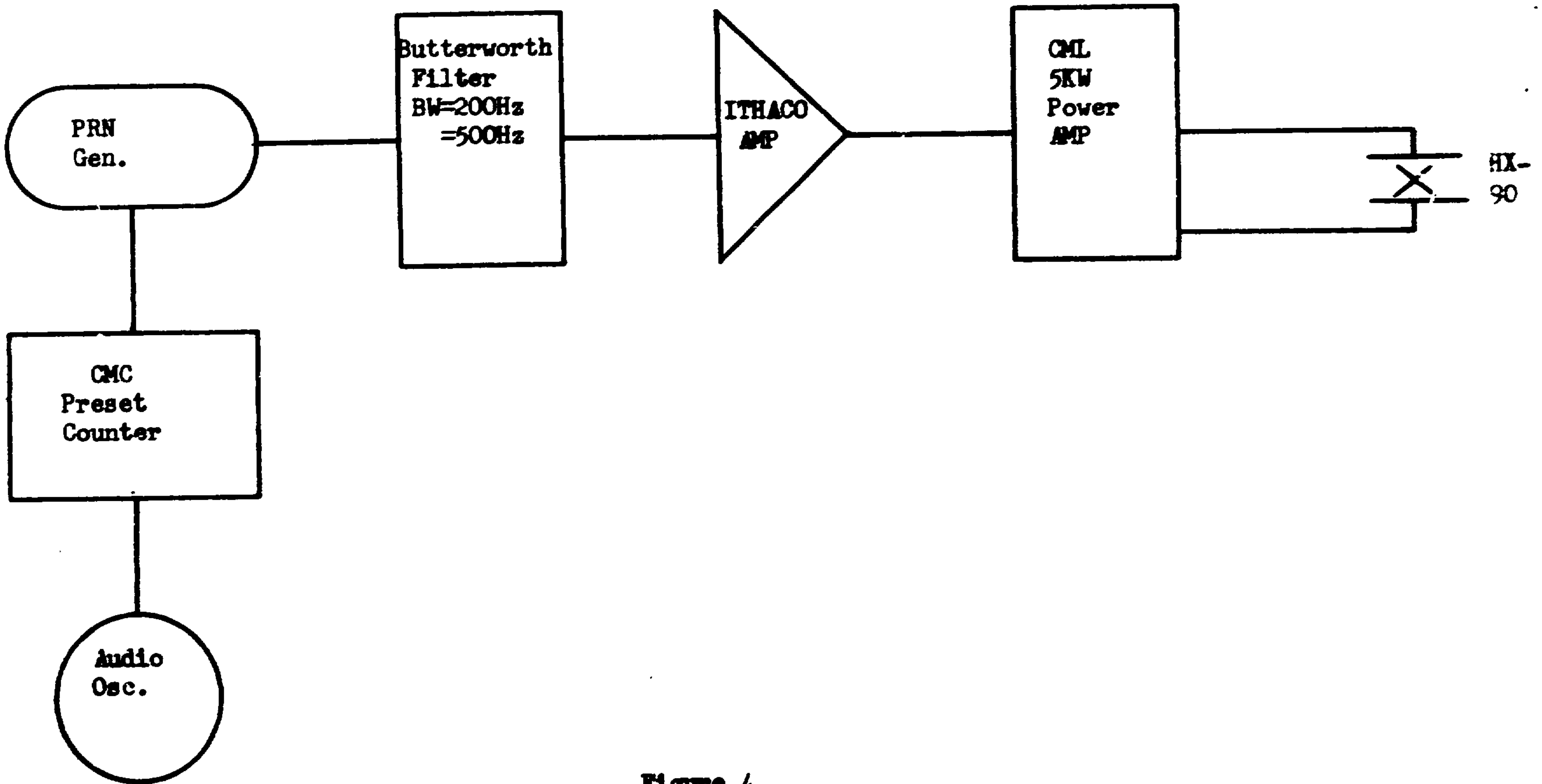


Figure 4

Transmitting System

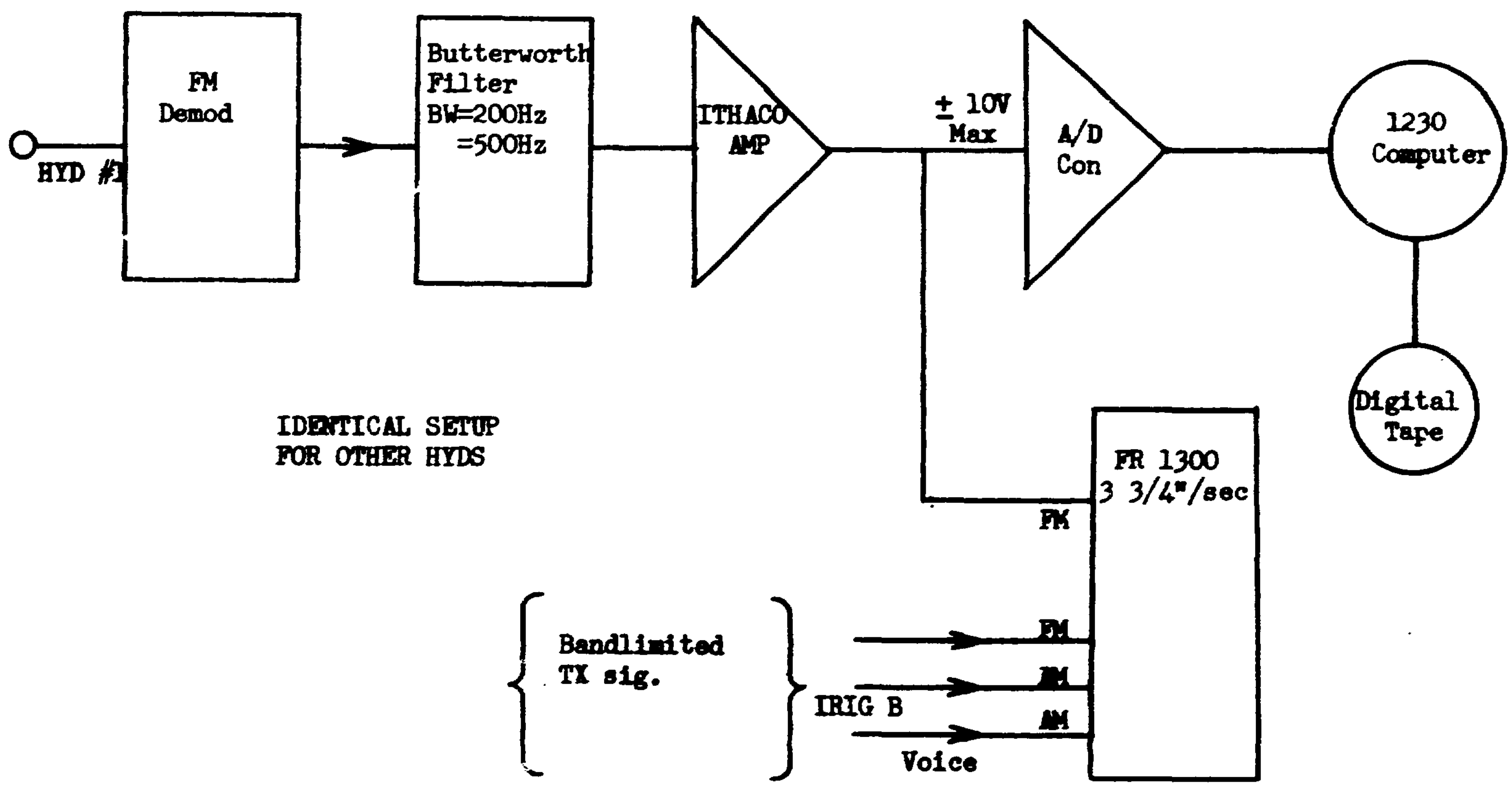
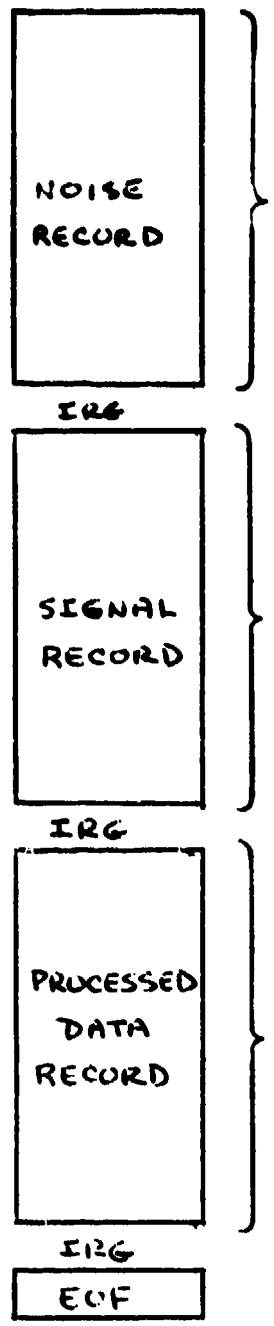


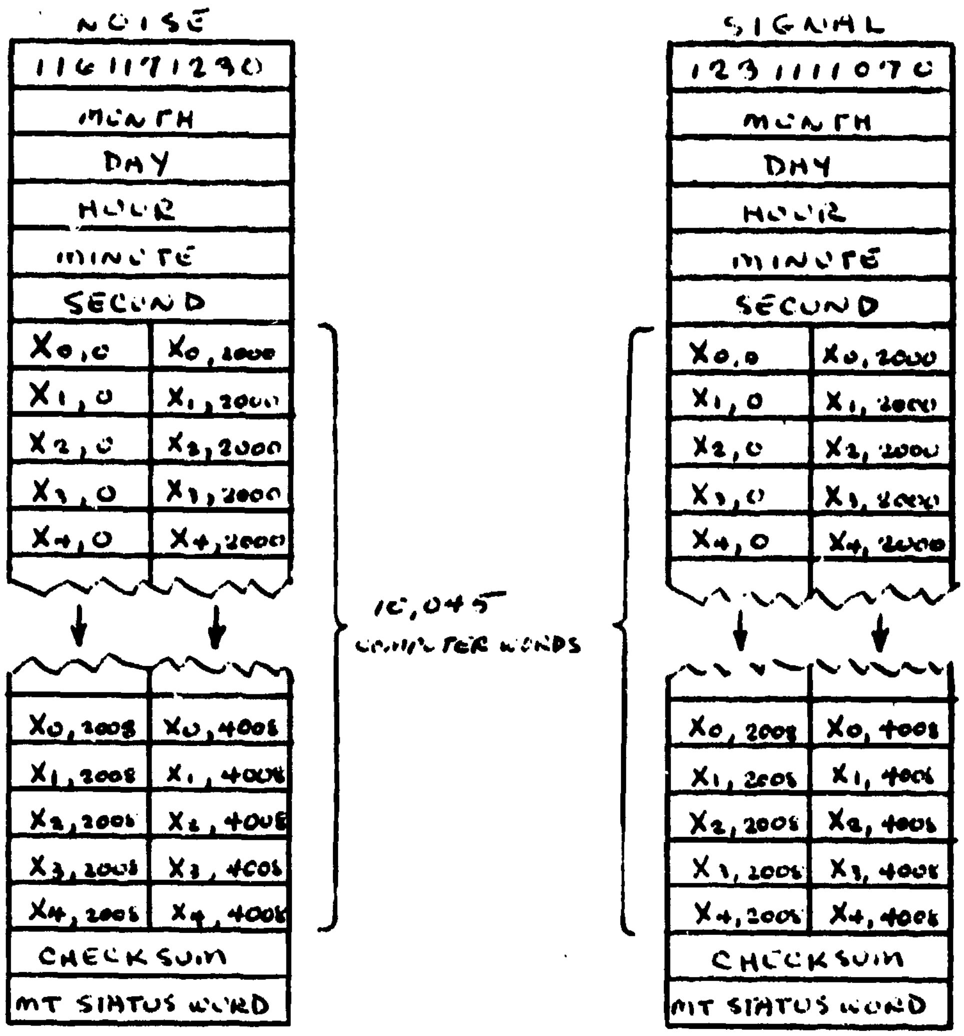
Figure 5

Receiving System for Single Hyd



MAGNETIC TAPE FORMAT

Figure 6



NOTES:

1. The first word of the NOISE record is "NOS" left justified in ASCII code.

2. The first word of the SIGNAL record is "SIG" left justified in ASCII code.

3. The last 45 words stored in the upper 15 bits of X are identical to the first 45 words stored in the lower 15 bits of X. This facilitated programming.

4. X3,2008 is interpreted as the 2009th sample on channel 3.

5. Data block X is comprised of 5 channels at 4009 samples each for a total of 20,045 unique data words in A/D code.

NOISE AND SIGNAL RECORDS

Figure 7

PROCESSED

120122117C	"PRO" IN ASCII CODE LEFT JUSTIFIED
MONTH	
DAY	
HOUR	
MINUTE	
SECOND	
NRMS	SEE THRESH
NOCRS	TRIGGER CRITERIA. NOCRS OF TOTCRS SAMPLES > THRESH
TOTCRS	
THRESH	THRESHOLD $= (\text{NRMS})\sqrt{\dfrac{\sum_{i}^{N-1} X_i^2}{N}}$ VOLTS. SF = 9 BITS
C	CONSTANT. SF = 9D
MF	MULTIPLICATION FACTOR
ITER	NO. OF SAMPLES/CHAN TO PROCESS PRIOR TO PRINTING PATTERN
FO	CENTER FREQUENCY
BW	BANDWIDTH
POW 181 WORDS	POW = P(e). SF = 15D. SEE EQUATION 2.
LPOW 181 WORDS	$\text{LPOW}_k = 10 \log \dfrac{\text{POW}_k}{\text{MAX}}$. SF = 12D.
WT 50 WORDS	WEIGHTS SF IS 18D BITS.
CHECK SUM	
MT STATUS WORD	

PROCESSED DATA RECORD

Figure 8

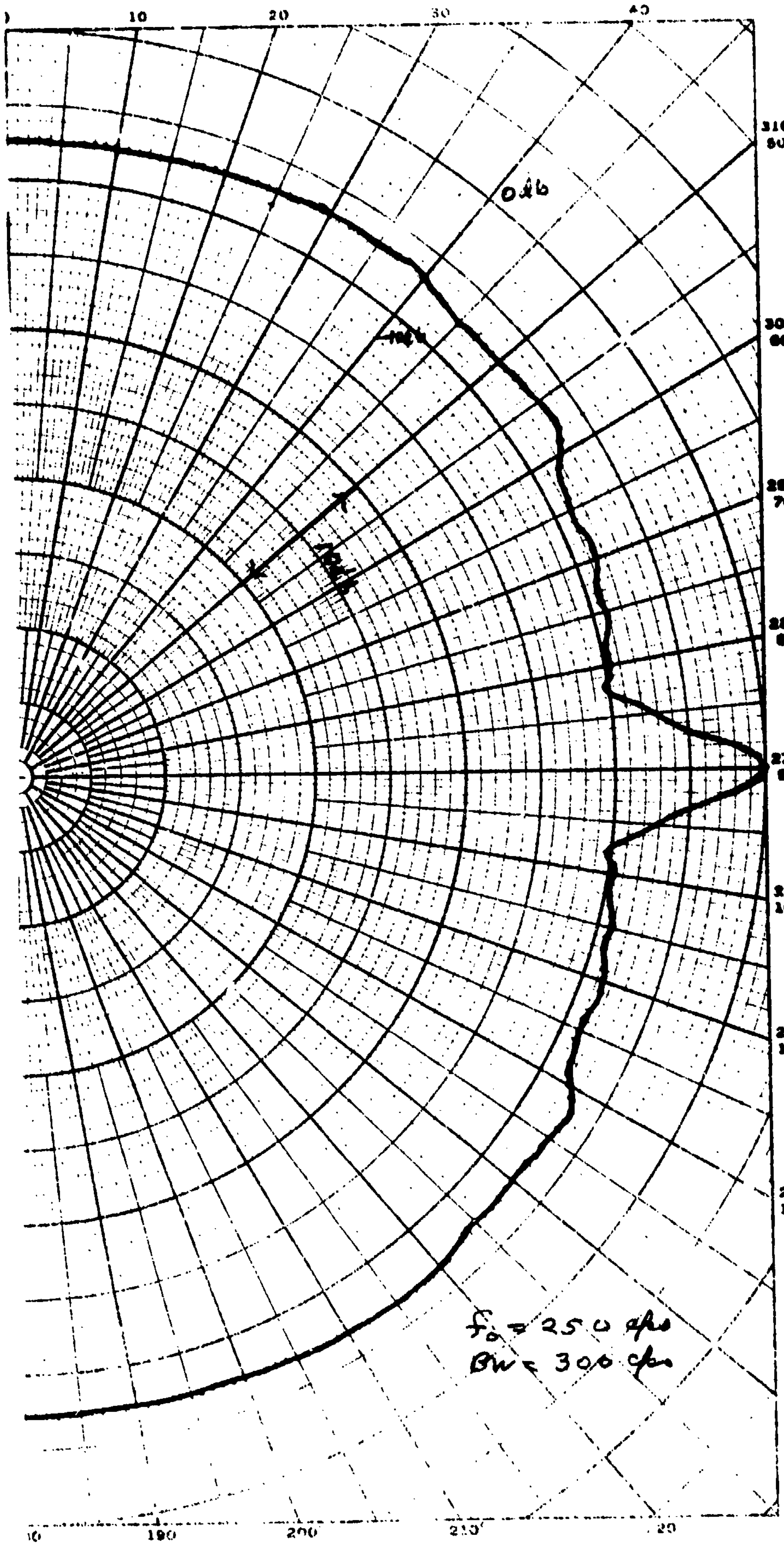

0
10
20
30
40
310°
50°
300°
60°
290°
70°
280°
80°
270°
90°
260°
100°
250°
110°
240°
120°
190
200
210
0 db
-10 db
f_o = 250 cps
BW = 300 cps

Figure 9

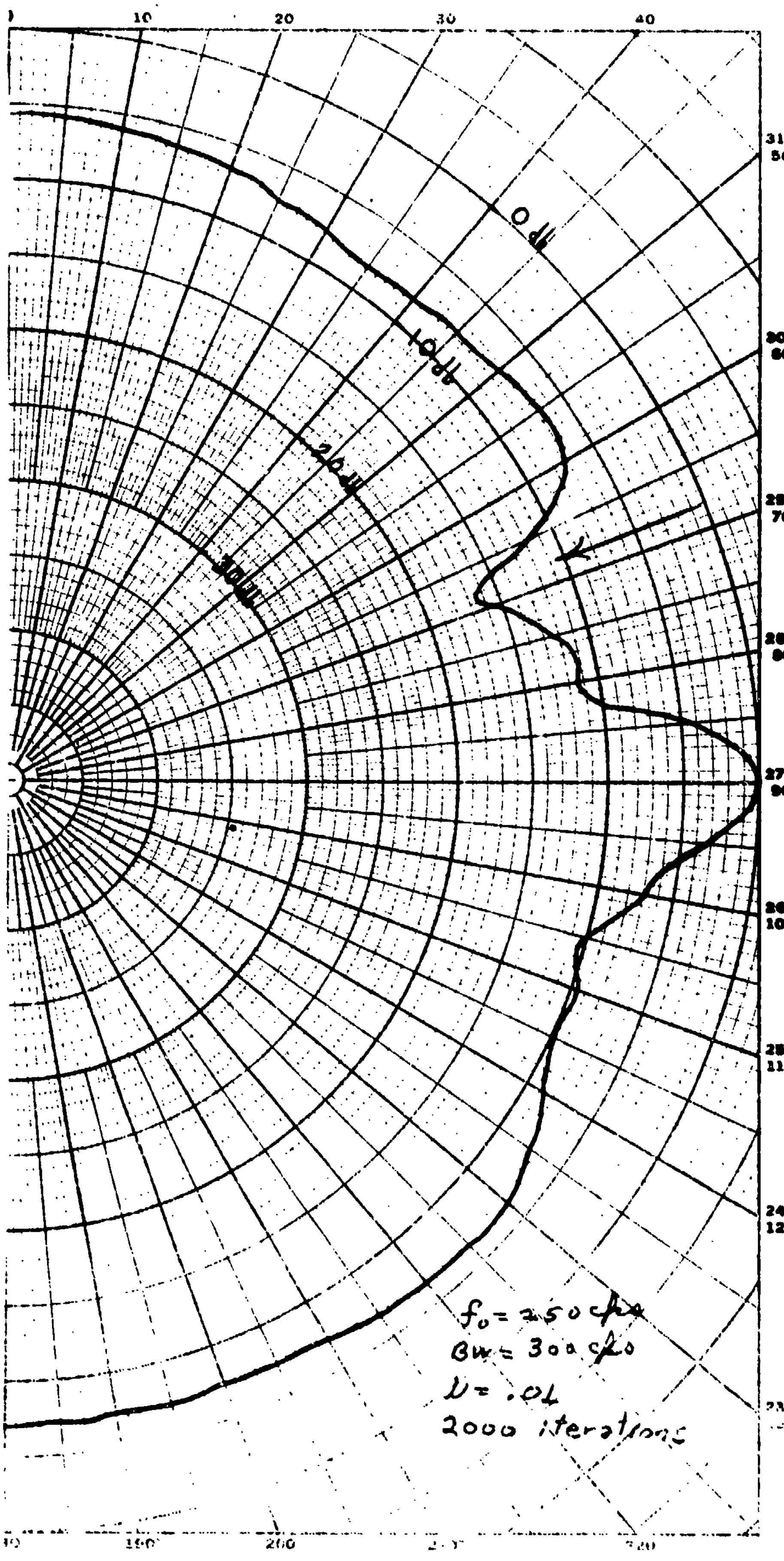

10
20
30
40
310
50
300
60
290
70
280
80
270
90
260
100
250
110
240
120
0 dB
10 dB
20 dB
30 dB
f_o = 250 cps
Bw = 300 cps
ν = .01
2000 iterations
200

Figure 10

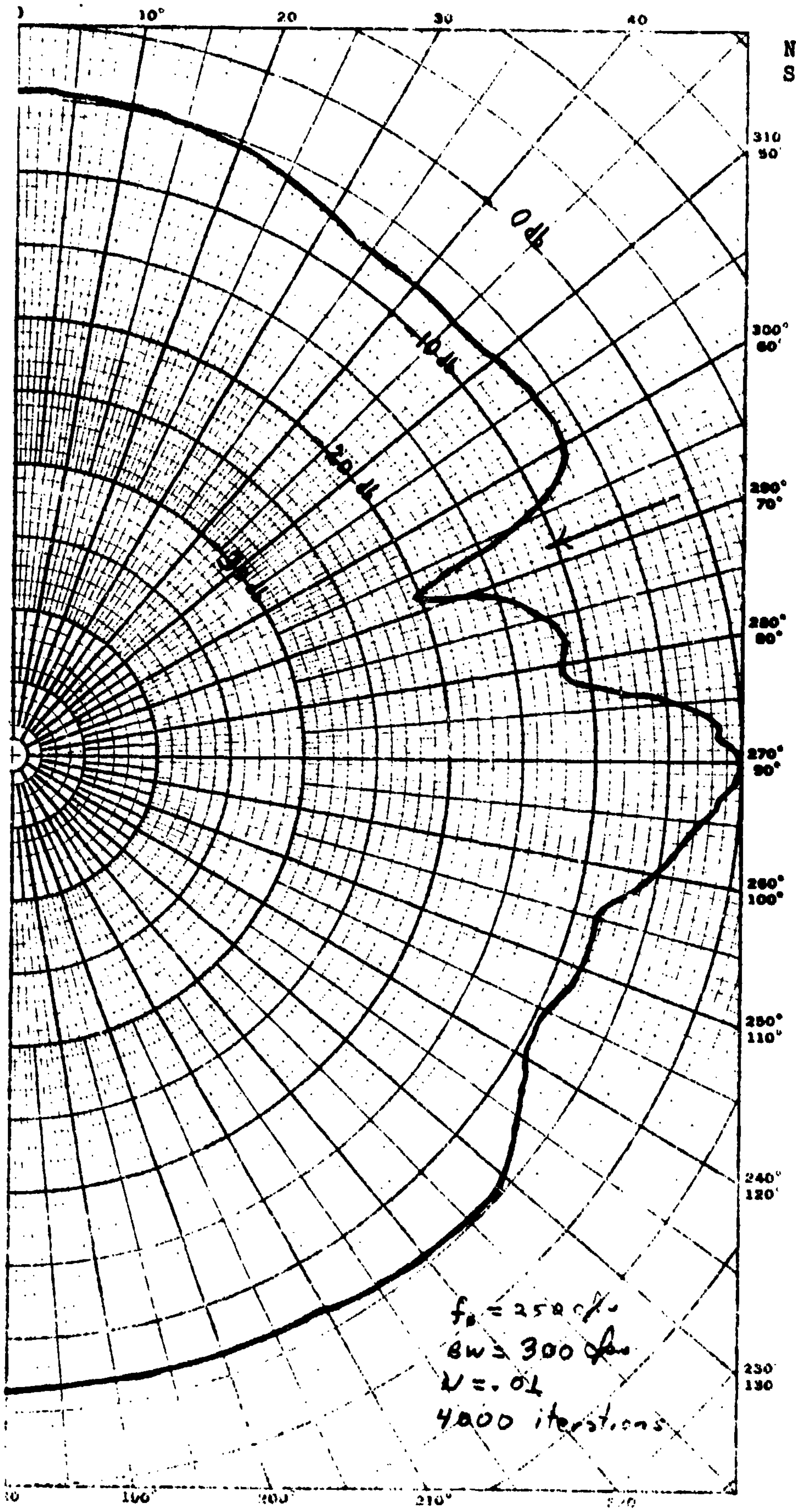

10°
20
30
40
310
50°
300°
60°
290°
70°
280°
80°
270°
90°
260°
100°
250°
110°
240°
120°
230
130
210°
0 db
-10 db
-20 db
$f_0 = 250$ c/s
BW = 300 c/s
ν = .01
4000 iterations

Figure 11

```
REVWTS   ENTRY
         STR*B1*L(RVB1)
         ENT*B1*4
         ENT*B5*45D
         ENT*B6*0
RV1      ENT*B4*4
RV2      ENT*A*W(WT+B6)
         ENT*Q*W(WT+B5)
         STR*A*W(WT+B5)
         STR*Q*W(WT+B6)
         ENT*B5*B5+1
         ENT*B6*B6+1
         BJP*B4*RV2
         ENT*B5*B5-10D
         BJP*B1*RV1
RVB1     ENT*B1*0
         EXIT
WTSPAT   ENTRY
         RJP*REVWTS
         RJP*PATTERN
         RJP*REVWTS
         EXIT
         PROCEDURE*CAB
         ENT*B2*0
         ENT*B3*0
TV       ENT*Q*U(X+B3)
         STR*Q*U(X+B2)
         ENT*B3*B3+1
         BSK*B2*49D
         JP*TV
L1U      STR*B0*W(Y)
L2U      ENT*Q*W(WT+B2)
         MUL*UX(X+B2)
         RSH*AQ*9D
         RPL*Y+Q*W(Y)
         BSK*B2*49D
         JP*L2U
         ENT*Q*W(Y)
         MUL*W(MF)
         STR*Q*W(Y)
L3U      ENT*Q*W(FST+B2)
         ENT*A*UX(X+B2)*ANEG
         SUB*Q*W(Y)*SKIP
         ADD*Q*W(Y)
         MUL*W(U)'SC = 27D
         RSH*AQ*9D'SC = 18D
         ENT*A*W(WT+B2)
         STR*A+Q*W(WT+B2)'SC IS 18D
         SUB*A*500000*ANEG
         RJP*SHIFTWTS
```

```
            BSK*B2*49D
            JP*L3U
            ENT*A*B3
            SUB*A*45D
            RSH*AQ*30D
            DIV*W(ITER)
            RJP*WTSPAT*AZERO
            ENT*B3*B3-46D
            BSK*B3*9999D
            JP*TV
LC          ENT*Q*L(X+B3)
            STR*Q*L(X+B2)
            ENT*B3*B3+1
            BSK*B2*49D
            JP*LC
            STR*B0*W(Y)
L2L         ENT*Q*W(WT+B2)
            MUL*LX(X+B2)
            RSH*AQ*9D
            RPL*Y+Q*W(Y)
            BSK*B2*49D
            JP*L2L
            ENT*Q*W(Y)
            MUL*W(MF)
            STR*Q*W(Y)
L3L         ENT*Q*W(FST+B2)
            ENT*A*LX(X+B2)*ANEG
            SUB*Q*W(Y)*SKIP
            ADD*Q*W(Y)
            MUL*W(D)'SC = 27D
            RSH*AQ*9D'SC = 18D
            ENT*A*W(WT+B2)
            STR*A+Q*W(WT+B2)'SC IS 18D
            SUB*A*5000000*ANEG
            RJP*SHIFTWTS
            BSK*B2*49D
            JP*L3L
            ENT*A*B3
            ADD*A*10000D
            SUB*A*45D
            RSH*AQ*30D
            DIV*W(ITER)
            RJP*WTSPAT*AZERO
            ENT*B3*B3-46D
            BSK*B3*9999D
            JP*LC
            RJP*WTSPAT
            RETURN
            END-PROC*CAD
```

```
BFC  1              LOC-DD
                    TABLE*WT*H*1*50D
                    END-TABLE*WT
          WP        EQUALS*WT
                    TABLE*WP*H*100*5
                    END-TABLE*WP
                    TABLE*DT*H*5*5
                    END-TABLE*DT
                    TABLE*PST*H*1*50D
                    FIELD*PS*FXWS*0*1*18D
                    END-TABLE*PST
                    TABLE*PSI*H*1*50D
                    FIELD*PS*FXWS*0*1*30D
                    END-TABLE*PSI
                    VRBL*MAX*FXW*18D
                    VRBL*POW*FXW*18D
                    VRBL*LPOW*FXW*12D
                    VRBL*TLPOW*FXW*12D
                    VRBL*DF*FXW*18D
                    VRBL*CI*FXW
                    VRBL*Y*FXW*18D
                    VRBL*SUM*FXW*18D
                    VRBL*T*FXW*18D
                    VRBL*PI*FXW*18D
                    VRBL*A1*FXW*18D
                    VRBL*DEL*FXW*24D
                    VRBL*BW*FXW
                    VRBL*FO*FXW
                    VRBL*C*FXW
                    VRBL*K*FXW
                    VRBL*TB*FXW*27D
                    VRBL*COS*FXW*27D
                    VRBL*SIN*FXW*27D
                    VRBL*I*FXW
                    VRBL*P*FXW
                    VRBL*M*FXW
                    VRBL*N*FXW
                    VRBL*A1M*FXW*27D
                    VRBL*A2M*FXW*27D
                    VRBL*SIN1*FXW*27D
                    VRBL*COS1*FXW*27D
                    VRBL*NF*FXW*27D
                    VRBL*CF*FXW*27D
                    VRBL*E*FXW
                    VRBL*S*FXW
                    VRBL*U*FXW*9D
                    VRBL*PRW1*FXW*18D
                    VRBL*WPN1*FXW*18D
                    VRBL*WPMO*FXW*18D
                    VRBL*PIBW*FXW*18D
```

```
              VRBL*EPS*FXW
              VRBL*COSC*FXW*27D
              VRBL*RPD*FXW*18D
              VRBL*SUM1*FXW*18D
              VRBL*SUM2*FXW*18D
              VRBL*SUM3*FXW*18D
              VRBL*CMNP*FXW*18D
              VRBL*SMNP*FXW*18D
              VRBL*PPI*FXW
              END-LOC-DD
              PROCEDURE*PATTERN
              ENT*B1*0
              SET*C*TO*5000D
              SET*PIBW*TO*(PI)(BW)
              SET*EPS*TO*1
              SET*SUM1*TO*0
              SET*CMNP*TO*0
P1            VARY*P*FROM*0*THRU*9D
              IF*P*NOT*0*THEN*SET*EPS*TO*2
M1            VARY*M*FROM*0*THRU*4
I1            VARY*I*FROM*0*THRU*9D-P
              SET*PPI*TO*P+I
              SET*A*TO*(WP(M,PPI))
              STR*A*W(WPMJ)
              SET*A*TO*(WP(M,I))
              STR*A*W(WPNI)
              SET*CMNP*TO*(WPMJ)(WPNI)+CMNP
              END*I1
              END*M1
              PUT*W(CMNP)*W(SMNP)
              PUT*0*W(CMNP)
              SET*T*TO*(P)(DEL)
              ENT*Q*W(BW)
              MUL*W(T)
              RSH*AQ*1'DIV BY 2 SC IS 18D
              LSH*AQ*12D'SC IS 30D
              RSH*A*30D'TRUNCATE WHOLE BAMS AND EXTEND SIGN
              RSH*AQ*3'SC IS 27D
              STR*Q*W(A1M)
              SINCOS*A1M*S*SIN1
              ENT*Q*W(FO)
              MUL*W(T)
              LSH*AQ*12D'SC IS 30D
              RSH*A*30D'TRUNCATE WHOLE BAMS AND EXTEND SIGN
              RSH*AQ*3'SC IS 27D
              STR*Q*W(A2M)      'SC IS 27D
              SINCOS*A2M*E*COS1
              SET*A1*TO*(PIBW)(T)
              SET*RPD*TO*(SIN1)(COS1)/A1
              IF*T*EQ*0*THEN*SET*RPD*TO*1
```

Appendix B

```
         SET*RPL*TO*(RPD)(LPS)
         SET*SUM1*TO*(RPD)(SMNP)+SUM1
         END*P1
I0       VARY*K*FROM*0*THRU*180D
         SET*T0*TO*K/360D
         SINCOS*T0*E*COS
         SET*SUM1*TO*0
         SET*SUM2*TO*0
         SET*SUM3*TO*0
         SET*COSC*TO*COS/C
N2       VARY*N*FROM*0*THRU*3
M2       VARY*M*FROM*N+1*THRU*4
I2       VARY*I*FROM*0*THRU*90
         SET*A*TO*(WP(M,I))
         STR*A*W(WPMI)
         SET*A*TO*(WP(N,I))
         STR*A*W(WPNI)
         SET*CMNP*TO*(WPMI)(WPNI)+CMNP
         END*I2
         PUT*W(CMNP)*W(SMNP)
         PUT*0*W(CMNP)
         SET*T*TO*(DT(M,N))(COSC)
         ENT*Q*W(BW)
         MUL*W(T)
         RSH*AQ*1'DIV BY 2 SC IS 18D
         LSH*AQ*12D'SC IS 30D
         RSH*A*30D'TRUNCATE WHOLE BAMS AND EXTEND SIGN
         RSH*AQ*3'SC IS 27D
         STR*Q*W(A1M)
         SINCOS*A1M*S*SIN1
         ENT*Q*W(F0)
         MUL*W(T)
         LSH*AQ*12D'SC IS 30D
         RSH*A*30D'TRUNCATE WHOLE BAMS AND EXTEND SIGN
         RSH*AQ*3'SC IS 27D
         STR*Q*W(A2M)
         SINCOS*A2M*E*COS1
         SET*A1*TO*(P1BW)(T)
         SET*RPL*TO*(SIN1)(COS1)/A1
         IF*T*EQ*0*THEN*SET*RPD*TO*1
         SET*SUM2*TO*(RPD)(SMNP)+SUM2
         END*M2
         END*N2
         SET*SUM2*TO*(2)(SUM2)
P3       VARY*P*FROM*1*THRU*90
M3       VARY*M*FROM*0*THRU*4
N3       VARY*N*FROM*0*THRU*4
         IF*M*EQ*N*THEN*GOTO*ON
I3       VARY*I*FROM*0*THRU*90-P
         SET*PP1*TO*P+1
```

```
              SET*A*TO*(WP(M,PPI))
              STR*A*W(WPMJ)
              SET*A*TO*(WP(N,I))
              STR*A*W(WPNI)
              SET*CMNP*TO*(WPMJ)(WPNI)+CMNP
              END*I3
              PUT*W(CMNP)*W(SMNP)
              PUT*U*W(CMNP)
              SET*T*TO*(P)(DEL)
              SET*T*TO*(DT(M,N));COSC)+T
              ENT*Q*W(BW)
              MUL*W(T)
              RSH*AQ*1'DIV BY 2 SC IS 18D
              LSH*AQ*12D'SC IS 30D
              RSH*A*30D'TRUNCATE WHOLE BAMS AND EXTEND SIGN
              RSH*AQ*3'SC IS 27D
              STR*Q*W(A1M)
              SINCOS*A1M*S*SIN1
              ENT*Q*W(FO)
              MUL*W(T)
              LSH*AQ*12D'SC IS 30D
              RSH*A*30D'TRUNCATE WHOLE BAMS AND EXTEND SIGN
              RSH*AQ*3'SC IS 27D
              STR*Q*W(A2M)
              SINCOS*A2M*E*COS1
              SET*A1*TO*(PIBW)(T)
              SET*RPD*TO*(SIN1)(COS1)/A1
              IF*T*EQ*0*THEN*SET*RPD*TO*1
              SET*SUM3*TO*(RPD)(SMNP)+SUM3
DN            NO-OP
              END*N3
              END*M3
              END*P3
              SET*SUM3*TO*(2)(SUM3)
              SET*SUM*TO*SUM1+SUM2+SUM3
              PUT*W(SUM)*W(POW+B1)
              INCREMENT*B1*1
              END*10
              ENT*B1*0
              CL*A
PM            ENT*Q*W(POW+B1)
              COM*Q*A*TMORE
              STR*Q*A
              BSK*B1*100D
              JP*PM
              STR*A*W(MAX)
              ENT*B1*20D
PM1           RJP*LFANDCR
              BJP*B1*PM1
              CLEAR*240*PLAD
```

```
         FORM-TEXT*PLAB*1*DEG -50   -45   -40   -35   -30   -25   -20   -151
   -10  -5   0    DECIBELS    WEIGHT'                                        2
         ENT*A*PLAB
         RJP*MONROE
NORMA    ENT*Q*W(POW+B1)
         CL*A
         LSH*AQ*15D
         DIV*W(MAX)
         CONLOGIT2'OUTPUT IS SCALED 12D
         STR*Q*W(LPOW+B1)
         STR*Q*W(TLPOW)'SC IS 12D
         STR*B1*W(K)
         CLEAR*24D*PLAB
         FORM-DEC*PLAB*61D*TLPOW
         ENT*A*49D
         SUB*A*B1*APOS
         JP*NWW
         ENT*A*W(WT+B1)
         STR*A*W(PRWT)
         FORM-DEC*PLAB*71D*PRWT
NWW      FORM-DEC*PLAB*1*K
         ENT*Q*W(DOTS)
         RPT*10D*ADV
         STR*Q*W(PLAB+1)
         ENT*Q*41
         LSH*Q*24D
         STR*Q*W(PLAB+11D)
         ENT*Q*W(TLPOW)'ALWAYS NEGATIVE
         SUB*Q*4000'ROUND
         RSH*Q*12D
         ADD*Q*50D*QPOS
         ENT*Q*5*SKIP
         ADD*Q*5
         CL*A
         DIV*5
         STR*Q*L(164)
         ENT*B5*A
         ENT*Q*W(MASK)
         CL*A
         RPT*B5
         RSH*AQ*6
         ENT*A*W(PLAB+B4)
         SEL*SU*W(POINTX)
         STR*A*W(PLAB+B4)
         ENT*A*PLAB
         RJP*MONROE
         BSK*B1*160D
         JP*NORMA
         RETURN
         END-PROC*PATTERN
```

DEPARTMENT OF THE NAVY
OFFICE OF NAVAL RESEARCH
800 NORTH QUINCY STREET
ARLINGTON, VA 22217-5660

IN REPLY REFER TO
5510/1
Ser 93/160
10 Mar 99

From: Chief of Naval Research
To: Commander, Naval Meteorology and Oceanography Command
1020 Balch Boulevard
Stennis Space Center MS 39529-5005

Subj: DECLASSIFICATION OF PARKA I AND PARKA II REPORTS

Ref: (a) CNMOC ltr 3140 Ser 5/110 of 12 Aug 97

Encl: (1) Listing of Known Classified PARKA Reports

1. In response to reference (a), the Chief of Naval Operations (N874) has reviewed a number of Pacific Acoustic Research Kaneohe-Alaska (PARKA) Experiment documents and has determined that all PARKA I and PARKA II reports may be declassified and marked as follows:

   Classification changed to UNCLASSIFIED by authority of Chief of Naval Research letter Ser 93/160, 10 Mar 99.

   DISTRIBUTION STATEMENT A: Approved for public release. Distribution is unlimited.

2. Enclosure (1) is a listing of known classified PARKA reports. The marking on those documents should be changed as noted in paragraph 1 above. When other PARKA I and PARKA II reports are identified, their markings should be changed and a copy of the title page and a notation of how many pages the document contained should be provided to Chief of Naval Research (ONR 93), 800 N. Quincy Street, Arlington, VA 22217-5660. This will enable me to maintain a master list of downgraded PARKA reports.

3. Questions may be directed to the undersigned on (703) 696-4619, DSN 426-4619.

Peggy Lambert

PEGGY LAMBERT
By direction

Copy to:
NUWC Newport Technical Library (Code 5441)
NRL Washington (Mary Templeman, Code 5227)
NRL SSC (Roger Swanton, Code 7031)
✓DTIC (Bill Bush, DTIC-OCQ)

LISTING OF KNOWN CLASSIFIED PARKA REPORTS

Operation Plan, Pacific Acoustic Research Kaneohe-Alaska PARKA Experiment, Undated, ONR, 48 pages
(NUSC NL Accession # 49531)

Fleet Research Project 109 PARKA II, Undated, COMASWFORPAC-OPORD-303-69, Antisubmarine Warfare Force, Pacific Fleet, Unknown # of pages
(NUSC NL Accession # 093561)

Preliminary Operation Plan Pacific Acoustic Research Kaneohe-Alaska PARKA Experiment, June 1968, ONR, Unknown # of pages
(NUSC NL Accession # 023063)

LRAPP Briefing Report on the PARKA Series, May 1969, MC Report 001, Maury Center for Ocean Science (ONR), 20 pages
(NUSC NL Accession # 023375)

Bathythermograph Traces from PARKA, 20 May 1969, NUSL-TM-2213-118-69, 7 pages
(DTIC # B952 259)

Bathymetric Strip Charts in the North Pacific Ocean for Project PARKA II, 20 June 1969, Naval Oceanographic Office, Unknown # of pages
(NUSC NL Accession # 051659)

PARKA II Experiment Utilizing Sea Spider ONR Scientific Plan 2-69, 26 June 1969, MC-PLAN-01, 172 pages
(DTIC # B020 846)

PARKA I - Acoustic Processing and Results, 28 July 1969, USL Technical Memorandum No. 2210-015-69, NUSC New London, 115 pages
(NUSC NL Accession # 202993-001) (NRL SSC Accession # 85009134)

A Scheduled At-Sea Simulation of Adaptive Beamforming, 19 September 1969, NUSL-TM-2211-162-69, 23 pages
(DTIC # B026 991)

Biological Data Collected on the PARKA I Transit, 23 October 1969, NUSL-TM-2213-262-69, 15 pages
(DTIC # B952 263)

PARKA I Experiment, November 1969, MC Report 003, Volume 1, Maury Center for Ocean Science (ONR), 84 pages
(NRL Accession # 466930) (NRL SSC Accession # 85004881) (DTIC # 506 209)

ENCLOSURE (1) TO CNR LTR
5510/1 SER 93/160 DTD
10 MAR 99